preparations the various conditions of a fungus, to which he gave a generic and a specific name, and although he professed to find the various conditions of spore, mycelium, and fructification occurring in their natural sequence, and that natural sequence to correspond with the regular advance of the pathological process, there is no doubt that this circumstantial account rests on erroneous observation and on defective evidence, and that the appearances found in the skin of the sheep are none other than those resulting from the coagulation of albuminoid fluids under particular circumstances.

XII. "Determination of Verdet's Constant in Absolute Units." By J. E. H. Gordon, B.A., Gonville and Caius College, Cambridge.—1st and 2nd Memoirs. Communicated by J. Clerk Maxwell. Received June 5, 1876.

(Abstract.)

[*Note.*—The whole of this work has been done under Prof. Clerk Maxwell's superintendence; he suggested the method and nearly all the details. He is, however, in no way responsible for any errors there may be in the numerical results.]

Introduction.

In the year 1845 Faraday discovered that if plane polarized light passes through certain media, and these media be acted on by a sufficiently powerful magnetic force, the plane of polarization is rotated.

About the year 1853 M. Verdet commenced a long and exhaustive examination of the subject, and his first result (published 'Ann. de Chimie et de Phys.' 3 série, tom. xli.) was that, for any given magnet and medium, "the ratio between the strength of the magnet and the amount of rotation is constant"*.

The object of the present research is to determine this constant in absolute measure—that is, in the C.G.S. system.

In order that the measurements may be expressed in absolute units, it is necessary to modify M. Verdet's mode of proceeding in several respects. In particular, an electromagnet with an iron core is unsuitable for this investigation, for both the amount and the distribution of the magnetic force between the poles depend on the properties of the iron core, and cannot be deduced from the strength of the current in the helix. Faraday's heavy glass and other media having the highest power of rotating the plane of polarization were also unsuitable to be used as standard media, on account of the difficulty of procuring specimens exactly alike. The following method was therefore adopted:—

The magnetic force was produced by means of an electric current in a

* This is expressed much more fully in Maxwell's 'Electricity,' vol. ii. p. 400, art. 808. The coefficient mentioned in the last line of the article may be defined as Verdet's constant. In the author's larger paper the identity of the two definitions is shown.

helix without an iron core, and bisulphide of carbon, enclosed in a tube with glass ends placed within the helix, was chosen as the medium.

The strength of the current in the helix was deduced from the deflection of a small magnet suspended near to it and outside it, and the rotation was measured by means of a divided circle.

The investigation then resolved itself into three parts :—

1. The determination of the constants of the helix.
2. The determination of the ratio which the rotation per unit of length bore to the tangent of the deflection of the suspended needle.
3. The determination of the horizontal component of the earth's magnetism at the time and place of observation.

THE EXPERIMENTS.

Determination of number of windings.

To determine the number of windings, it is necessary to know the difference of magnetic potential at the ends of the helix when a unit current passes in the wire.

To determine this the author places the helix and great dynamometer coaxial, and suspends a magnet and mirror at the centre of the dynamometer. By sliding the helix endways along the axis, so as to bring different points of it over the suspended mirror, he obtains the magnetic intensity at these points in terms of that of the dynamometer, which is known. Varying currents are set in opposite directions through helix and dynamometer till the action on the suspended magnet is zero. By integrating these values along the axis between limits corresponding to the ends of the helix the difference of magnetic potential at the ends for a unit current is determined. A rule known as Weddle's (see Boole's 'Finite Differences,' p. 47) is used for the integration.

This difference is called N, and from it is deduced the number of windings (n) by Maxwell's 'Electricity,' art. 676. After describing the mechanical arrangements and giving a drawing of the connexions, the author gives a Table showing the results of the experiments for the determination of N.

The final results are

$$N = 10752,$$
$$n = 1028{\cdot}15.$$

By an equation of units N is shown to be the ratio of two things of the same dimensions, and therefore a number.

Determination of Areas.

To calculate the strength of a current in a helix from the deflection of a magnet suspended outside it, it is necessary to know $\Sigma(A)$, the sum of the areas of the windings.

This was obtained by comparing the action of the helix on such a magnet

with those of coils of known areas. Two coils were used, a small one and the great electro-dynamometer of the British Association. With the small coil the same currents were sent through a coil and helix, and the distances from the suspended magnet varied; while with the large one the distances were the same and the currents varied. These latter experiments were made by Prof. Maxwell.

The following values were then obtained for the area of the helix:—

By the author with small dynamometer,

$$\Sigma(A)=77417{\cdot}2 \text{ sq. centims.};$$

by Prof. Maxwell with large dynamometer,

$$\Sigma(A)=77488{\cdot}8 \text{ sq. centims.};$$

the mean, 77453·0, of these was adopted.

Calculation of the strength of the current in terms of the deflection δ of the magnet suspended outside the helix and in the bisecting plane perpendicular to its axis.

The author shows that this is

$$C=\frac{Hr^3}{\Sigma(A)}\tan\delta,$$

where r is the distance from the suspended magnet to either end of the axis of the helix, and H the horizontal component of the earth's magnetism at the time and place of observation.

Formula for ω.

ω is the rotation of the polarized ray expressed in circular measure between two points in its path, whose magnetic potential differs by unity; thus

$$\omega=\frac{\theta}{V_L-V_M},$$

where L and M are the ends of the tube, and θ is half the difference of the circle readings expressed in circular measure.

An approximation is given for the difference of potentials at the ends of a tube (A B) of finite length projecting at each end of the helix (L M). The letters being in the order A, L, M, B, the formula for ω becomes

$$\omega=\frac{\theta}{\left\{4\pi n-(\Sigma(A))\left(\frac{1}{LA\,.\,LB}+\frac{1}{MA\,.\,MB}\right)\right\}\frac{Hr^3\tan\delta}{\Sigma(A)}}.$$

Tan δ.

The author explains at length the method of adjusting the telescope and scale.

A formula for deducing the angular deflection from the scale-reading is obtained.

The Light.

Monochromatic light was used, obtained by throwing a spectrum on a card, in which was a slit to admit the colour required. A method of localizing the light used is given.

The following results for $\frac{2R}{y}$, where $y \equiv \tan \delta$, are given, and the wave-length of the light was that of the green thallium line :—

Set.	2R.	Grove's cells.	$\frac{2R}{y}=\frac{\text{Const.}}{H}$.
2....	11° 58′ 30″	5	8861·1 min.
3....	13° 39′ 30″	6	8820·6 min.
1....	15° 26′ 0″	7	8917·5 min.

where 2R is the difference of the circle readings corresponding to the two directions of the current.

Value of H.

This was determined by vibrating the same magnet at Kew and at the author's laboratory at Pixholme, Dorking, where all the optical part of the work was done, and then deducing the force at Pixholme from the Kew magnetograph curves at the times of experiment. The magnet used was very kindly lent to the author by Mr. Whipple.

The result obtained was

$$\text{H at Pixholme} = (\cdot 993366)\ \text{H at Kew}.$$

Value of the Constant.

The values of H at Pixholme at the times of the optical experiments having been calculated, we have for the three values of the quantity which should be constant :—

$$\frac{2R}{yH} = \left\{\begin{array}{l} 1 \ldots\ldots 50118\cdot 4 \\ 2 \ldots\ldots 49767\cdot 0 \\ 3 \ldots\ldots 49538\cdot 7 \end{array}\right\} \begin{array}{c}\text{mean} \\ 49808\cdot 0.\end{array}$$

Extreme difference 0·6 per cent.

We have finally, if ω be the rotation in bisulphide of carbon of the plane of polarization of the ray whose wave-length is

$$\lambda = (5\cdot 349)10^{-5}$$

between two points whose magnetic potentials differ by unity,

$$\omega = 3\cdot 04763(10^{-5}).$$

The dimensions of the constant are

$$[\omega] = [M^{-\frac{1}{2}}L^{-\frac{1}{2}}T].$$

The paper concludes with a few very inadequate words of thanks to Prof. Maxwell for his great kindness in superintending the whole of the work for the year and eight months during which it has been in progress.

The author also records his thanks to Mr. Whipple and several other friends for assistance and suggestions.

An Appendix contains an analysis of the bisulphide used.